

CLAIMS

1. A transmitter apparatus comprising:

an input receiving section that receives inputs of multiple synchronized signals r_1, \dots, r_N ;

an synchronizing section that delays the multiple input received synchronized signals r_1, \dots, r_N by time t_1, \dots, t_N to output multiple synchronized signals v_1, \dots, v_N ;

a modulating section that modulates the output multiple synchronized signals v_1, \dots, v_N to output modulated signals w_1, \dots, w_L ($1 \leq L \leq N$); and

a transmitting section that transmits the output modulated signals w_1, \dots, w_L , wherein the delay time t_1, \dots, t_N is shorter than a reciprocal number of a minimum value of clock rates of the multiple input received synchronized signals r_1, \dots, r_N .

2. The transmitter apparatus according to claim 1, further comprising:

a storing section that stores the delay time t_1, \dots, t_N in advance, wherein the synchronizing section delays the respective multiple synchronized signals r_1, \dots, r_N by the time t_1, \dots, t_N stored in the storing section.

3. The transmitter apparatus according to claim 1, wherein the modulating section classifies the synchronized signals v_1, \dots, v_N into L ($L \leq N$) signal groups to send the respective classified L signal groups to any one of L spread spectrum modulators not to be overlapped with one another to output the modulated signals w_1, \dots, w_L .

4. The transmitter apparatus according to claim 3, wherein the transmitting section radio-transmits the respective modulated signals w_1, \dots, w_L by L radio frequency modulators each using a different carrier frequency.

5. The transmitter apparatus according to claim 3, wherein the transmitting section sends the modulated signals w_1, \dots, w_L to I-channels and Q-channels of each of $L/2$ radio frequency modulators each using a different carrier frequency not to be overlapped with one another to radio-transmit the respective obtained transmitting signals.

6. The transmitter apparatus according to claim 3, wherein $L = 2$ is established.

7. The transmitter apparatus according to claim 1, wherein the delay time t_1, \dots, t_N is proportional to u_1, \dots, u_N . that is determined by the following equation by a prestored integer value a and a predetermined nonlinear transformation $f(\cdot)$ over a finite field:

$$u_1 = a;$$

$$u_{j+1} = f(u_j) \quad (1 \leq j < N).$$

8. The transmitter apparatus according to claim 7, wherein the prestored value a is updated to $a = f(u_N)$ every time when predetermined time passes, and thereby the delay time t_1, \dots, t_N is updated.

9. The transmitter apparatus according to claim 7, wherein the predetermined nonlinear transformation $f(\cdot)$ over a finite field corresponds to any one of the following (a) to (e):

- (a) transformation using a Chebyshev polynomial of second or more degree,
- (b) transformation using Bernoulli mapping,
- (c) transformation $f(x) = 2x^2 - px + q \pmod{2^w}$ defined using integers p, q ($p \pmod{4} = 1, 0 \leq q \leq 2^w - 1$),
- (d) transformation using a remainder obtained by dividing any one of transformation

results of (a) to (c) by a predetermined integer, and

(e) transformation that is the same form as any one of the above (a) to (d) by a linear coordinate transformation.

10. A receiver apparatus comprising:

a receiving section that receives multiple signals as a_1, \dots, a_L ($1 \leq L$);

a delaying section that delays the respective multiple received signals a_1, \dots, a_L by time $T - t_1, \dots, T - t_N$ ($L \leq N$) where T is predetermined constant time without being overlapped with one another to output multiple intermediate signals p_1, \dots, p_N ;

a demodulating section that demodulates the multiple output intermediate signals p_1, \dots, p_N to output demodulated signals r_1, \dots, r_N ; and

an outputting section that outputs the multiple output demodulated signals r_1, \dots, r_N as multiple transmitted synchronized signals.

11. The receiver apparatus according to claim 10, further comprising:

a storing section that stores the predetermined constant time T and time t_1, \dots, t_N in advance,

wherein the delaying section obtains delay time of the respective multiple synchronized signals r_1, \dots, r_N from time stored in the storing section and delays the synchronized signals by time $T - t_1, \dots, T - t_N$.

12. The receiver apparatus according to claim 10, wherein the delaying section classifies the delay time $T - t_1, \dots, T - t_N$ into L delay time groups, and uses the respective classified L delay time groups not to be overlapped with the received signals a_1, \dots, a_L to output the intermediate signals p_1, \dots, p_N .

13. The receiver apparatus according to claim 12, where the receiving section obtains the respective received signals a_1, \dots, a_L from L radio frequency modulators each using a different carrier frequency.

14. The receiver apparatus according to claim 12, wherein the receiving section obtains the received signals a_1, \dots, a_L from I-channels and Q-channels of each of $L/2$ radio frequency modulators each using a different carrier frequency not to be overlapped with one another.

15. The receiver apparatus according to claim 14, wherein $L = 2$ is established.

16. The receiver apparatus according to claim 10, wherein the time t_1, \dots, t_N is proportional to u_1, \dots, u_N . that is determined by the following equation by a prestored integer value a and a predetermined nonlinear transformation $f(\cdot)$ over a finite field:

$$u_1 = a;$$

$$u_{j+1} = f(u_j) \quad (1 \leq j < N).$$

17. The receiver apparatus according to claim 16, wherein the prestored value a is updated to $a = f(u_N)$ every time when predetermined time passes, and thereby the delay time t_1, \dots, t_N is updated.

18. The receiver apparatus according to claim 16, wherein the predetermined nonlinear transformation $f(\cdot)$ over a finite field corresponds to any one of the following (a) to (e):

(a) transformation using a Chebyshev polynomial of second or more degree,

(b) transformation using Bernoulli mapping,

(c) transformation $f(x) = 2x^2 - px + q \pmod{2^w}$ defined using integers p, q ($p \bmod 4 = 1, 0 \leq q \leq 2^w - 1$),

(d) transformation using a remainder obtained by dividing any one of transformation results of (a) to (c) by a predetermined integer, and

(e) transformation that is the same form as any one of the above (a) to (d) by a linear coordinate transformation.

19. A transmission method comprising:

the input receiving step of receiving inputs of multiple synchronized signals r_1, \dots, r_N ;

the asynchronizing step of delaying the multiple input received synchronized signals r_1, \dots, r_N by time t_1, \dots, t_N to output multiple asynchronized signals v_1, \dots, v_N ;

the modulating step of modulating the output multiple asynchronized signals v_1, \dots, v_N to output modulated signals w_1, \dots, w_L ($1 \leq L \leq N$); and

the transmitting step of transmitting the output modulated signals w_1, \dots, w_L , wherein the delay time t_1, \dots, t_N is shorter than a reciprocal number of a minimum value of clock rates of the multiple input received synchronized signals r_1, \dots, r_N .

20. The transmission method according to claim 19,

wherein a storing section that stores the delay time t_1, \dots, t_N in advance is used; and wherein the respective multiple synchronized signals r_1, \dots, r_N are delayed by the time t_1, \dots, t_N stored in the storing section in the asynchronizing step.

21. The transmission method according to claim 19, wherein the asynchronized signals v_1, \dots, v_N are classified into L ($L \leq N$) signal groups and the respective classified L signal groups are sent to any one of L spread spectrum modulators not to be overlapped

with one another to output the modulated signals w_1, \dots, w_L in the modulating step.

22. The transmission method according to claim 21, wherein the respective modulated signals w_1, \dots, w_L are radio-transmitted by L radio frequency modulators each using a different carrier frequency in the transmitting step.

23. The transmission method according to claim 21, wherein the modulated signals w_1, \dots, w_L are sent to I-channels and Q-channels of each of $L/2$ radio frequency modulators each using a different carrier frequency not to be overlapped with one another to radio-transmit each of the obtained transmitting signals in the transmitting step.

24. The transmission method according to claim 23, wherein $L = 2$ is established.

25. The transmission method according to claim 19, wherein the delay time t_1, \dots, t_N is proportional to u_1, \dots, u_N . that is determined by the following equation by a prestored integer value a and a predetermined nonlinear transformation $f(\cdot)$ over a finite field:

$$u_1 = a;$$

$$u_{j+1} = f(u_j) \quad (1 \leq j < N).$$

26. The transmission method according to claim 25, wherein the prestored value a is updated to $a = f(u_N)$ every time when predetermined time passes, and thereby the delay time t_1, \dots, t_N is updated.

27. The transmission method according to claim 25, wherein the predetermined nonlinear transformation $f(\cdot)$ over a finite field corresponds to any one of the following (a) to (e):

- (a) transformation using a Chebyshev polynomial of second or more degree,
- (b) transformation using Bernoulli mapping,
- (c) transformation $f(x) = 2x^2 - px + q \pmod{2^w}$ defined using integers p, q ($p \pmod{4} = 1, 0 \leq q \leq 2^w - 1$),
- (d) transformation using a remainder obtained by dividing any one of transformation results of (a) to (c) by a predetermined integer, and
- (e) transformation that is the same form as any one of the above (a) to (d) by a linear coordinate transformation.

28. A reception method comprising:

- the receiving step of receiving multiple signals as a_1, \dots, a_L ($1 \leq L$);
- the delaying step of delaying the respective multiple received signals a_1, \dots, a_L by time $T - t_1, \dots, T - t_N$ ($L \leq N$) where T is predetermined constant time without being overlapped with one another to output multiple intermediate signals p_1, \dots, p_N ;
- the demodulating step of demodulating the multiple output intermediate signals p_1, \dots, p_N to output demodulated signals r_1, \dots, r_N ; and
- the outputting step of outputting the multiple output demodulated signals r_1, \dots, r_N as multiple transmitted synchronized signals.

29. The reception method according to claim 28,

- wherein a storing section that stores the predetermined constant time T and time t_1, \dots, t_N in advance is used; and
- wherein delay time of the respective multiple synchronized signals r_1, \dots, r_N is obtained from time stored in the storing section and the synchronized signals are delayed by the time $T - t_1, \dots, T - t_N$ in the delaying step.

30. The reception method according to claim 28, wherein the delay time $T - t_1, \dots, T - t_N$ are classified into L delay time groups, and the respective classified L delay time groups are used not to be overlapped with the received signal a_1, \dots, a_L to output the intermediate signals p_1, \dots, p_N in the delaying step.

31. The reception method according to claim 30, where the respective received signals a_1, \dots, a_L are obtained from L radio frequency modulators each using a different carrier frequency in the receiving step.

32. The reception method according to claim 30, wherein the received signals a_1, \dots, a_L are obtained from I-channels and Q-channels of each of $L/2$ radio frequency modulators each using a different carrier frequency not to be overlapped with one another in the receiving step.

33. The reception method according to claim 32, wherein $L = 2$ is established.

34. The reception method according to claim 28, wherein the time t_1, \dots, t_N is proportional to u_1, \dots, u_N . that is determined by the following equation by a prestored integer value a and a predetermined nonlinear transformation $f(\cdot)$ over a finite field:

$$u_1 = a;$$

$$u_{j+1} = f(u_j) \quad (1 \leq j < N).$$

35. The reception method according to claim 34, wherein the prestored value a is updated to $a = f(u_N)$ every time when predetermined time passes, and thereby the delay time t_1, \dots, t_N is updated.

36. The reception method according to claim 34, wherein the predetermined nonlinear transformation $f(\cdot)$ over a finite field corresponds to any one of the following

(a) to (e):

- (a) transformation using a Chebyshev polynomial of second or more degree,
- (b) transformation using Bernoulli mapping,
- (c) transformation $f(x) = 2x^2 - px + q \pmod{2^w}$ defined using integers p, q ($p \pmod{4} = 1, 0 \leq q \leq 2^w - 1$),
- (d) transformation using a remainder obtained by dividing any one of transformation results of (a) to (c) by a predetermined integer, and
- (e) transformation that is the same form as any one of the above (a) to (d) by a linear coordinate transformation.

37. A program causing a computer (including FPGA (Field Programmable Gate Array), DSP (Digital Signal Processor), ASIC (Application Specific Integrated Circuit)) to function as the respective sections described in claim 1.

38. A program causing a computer (including FPGA (Field Programmable Gate Array), DSP (Digital Signal Processor), ASIC (Application Specific Integrated Circuit)) to function as the respective sections described in claim 10.